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THE IMPACT OF ADOPTING PHYSICAL FITNESS STANDARDS ON ARMY PERSONNEL ASSIGNMENT: A PRELIMINARY STUDY

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The research literature on physical strength and stamina was reviewed to determine the probable impact of the physical demands classification for Military Occupational Specialties (MOS) proposed by the Army Research Institute for Environmental Medicine (ARIEM). The minimum standards for stamina were well within the capacity of the majority of current soldiers, but strength requirements may exclude a substantial number of persons,

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especially women, from a majority of Army jobs. The number of people excluded will depend very much upon the precise conditions for testing strength.

Many of the MOS with high physical demands are in technical areas which require persons with high mental aptitude. In many instances, there is already a personnel shortage for these jobs which will be aggravated by imposing physical demands standards, especially if many other high aptitude MOS are competing on the basis of the same strength criteria. This problem can be alleviated by changing the job to minimize the physical demands, using techniques such as job modification, job aids, or task reassignment. Not only will such changes increase the number of persons available, but these changes will also have the side benefit of reducing the number of job-related injuries. The changes will also provide wider and more efficient utilization of the pool of female soldiers available to the Army.

A research effort is proposed for examining five critical MOS that are both physically demanding (according to ARIEM standards) and that require high mental aptitude for success to develop and evaluate a general procedure for conducting job analyses related to physical demands and to recommend specific job changes for these MOS.

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FOREWORD

The Fort Hood Field Unit of the US Army Research Institute for the Behavioral and Social Sciences (ARI) conducts research in a variety of areas related to the needs of the Army in the field and provides support to Headquarters, TCATA (TRADOC Combined Arms Test Activity). This support is provided by assessing human performance aspects in field evaluations of man/weapons systems.

This report presents a preliminary evaluation of the impact which would result from the Army's adoption of physical demand standards for all enlisted Military Occupational Specialties (MOS). These standards were developed by the Army Research Institute for Environmental Medicine (ARIEM) at the request of the Surgeon General. While the aim of these standards is laudable--to improve the combat readiness of the Army by ensuring all soldiers are physically able to accomplish their job--FORSCOM recognized that there might be undesirable side effects of adopting the system. Through III Corps, it requested ARI to evaluate the impact of the standards. The primary emphasis of that evaluation was on the possible effects implementation would have on the number of soldiers available for MOS which also require high aptitude. This was done by determining how many soldiers are in MOS having both high physical demands and high aptitude requirements. Predictions were made about expected personnel shortfall based on previous research on the physical abilities of comparable populations. Ways to reduce the impact of the ARIEM physical demands selection procedure were considered and the benefits of these examined.

ARI research in this area is conducted as an in-house effort, and as joint efforts with organizations possessing unique capabilities for human factors research. The research described in this report was done by personnel of the Human Resources Research Organization (HumRRO), under Contract No. MDA903-79-C-0191, monitored by Dr. Charles O. Nystrom from the ARI Fort Hood Field Unit. Dr. Richard L. Palmer served as alternate monitor. This research is responsive to the special requirements of TCATA and the objectives of RDTE Project 2Q263743A796, "Human Performance in Field Assessment," FY 1980 Work Program.

CONTENTS

Chapter 1

BACKGROUND

In the modern Army many arduous jobs that used to require muscle power are now handled by machines, just as are many of the heavy jobs in the civilian sector. Heavy equipment is now used to move guns, ammunition and supplies. Instead of marching into battle, today's infantry soldier often rides in an armored personnel carrier. However, there are still many jobs in the Army that require a high level of physical fitness, both in terms of strength and in terms of stamina. Today's soldier, like those in past times, must be prepared to fight anywhere in the world in all types of terrain and in all types of weather. In addition to carrying weapons (which in some cases may have become lighter) the infantry soldier must also carry many new pieces of gear such as special electronic equipment for communication and for detection of the enemy which did not exist 20 years ago. Trucks, armored personnel carriers, tanks, and other heavy equipment may break down and require repairs that involve lifting heavy parts. New weapons in the radiological, chemical and biological fields mean that today's soldier must be prepared to carry the weight of additional protective equipment. Modern equipment such as night vision goggles has made the 24-hour battle day a reality, and today's soldier must have the stamina to fight for longer periods of time without rest than ever before. In short, the need for a physically fit soldier may be even greater today than it ever was.

The Current Physical and Medical Fitness System

The Army has taken steps at various times to ensure that soldiers were fit for combat. The current selection system, which is based on physicians' judgment of physical and medical fitness in six areas, has been in use for enlisted personnel since 1945 and for officers since 1952. The system has the acronym, PULHES, which stands for:

P Physique, or general physical capacity;
U Upper extremity;
L Lower extremity;
H Hearing and ears (defects or disease);
E Eyes (defects or disease) and vision; and
S Neuropsychiatry.[1]

This system was based on a similar one adopted by the Royal Canadian Army in 1943 called PULHEMS. Another system, called PULHESX, has been used by the US Air Force with the additional X factor standing for stamina.[2]

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[1] E. C. Jacobs. PULHES: The physical profile serial system. U.S. Armed Forces Medical Journal, 1953, 4, 235-241.

[2] K. G. Koym. Development of physical demand profiles for four airman career ladders (AFHRL-TR-75-67). Brooks Air Force Base, Texas: Air Force Human Resources Laboratory, November 1975, p 5.

PULHES is a form of job specification which can be used by nonmedical personnel. The pattern of six PULHES digits is called the soldier's profile. Every Military Occupational Specialty (MOS) in the Army has been given a minimum PULHES profile and only those soldiers meeting this minimum profile can be assigned to that MOS. Jacobs explained how the test was to be used when it was first introduced:

> Each of these factors is considered and given a separate grade, ranging from 1 to 4, according to a person's functional ability in that factor. Number 1 represents higher than average efficiency with minimal or no physical defects; 2 indicates average efficiency with a mild physical defect; 3 represents below-average efficiency with a moderate physical defect which must not prevent the performance of some military duty in a satisfactory manner and must not be progressive in nature (grades 1, 2, and 3 are acceptable for military service); and 4 indicates poor efficiency due to a marked physical defect which renders a person unacceptable for military service except during a national emergency when specifically authorized by special directive.[3]

The minimum requirements have been changed at various times since World War II when Jacobs made his comments. Today, a soldier must have all 1s or 2s in his or her profile to be fit for world wide assignment. A 3 or 4 in any factor is disqualifying for entrance into the Army but is acceptable for continuation in an MOS with some restrictions on duties or location. The requirements for physically demanding MOS may be even more stringent. Infantry specialties, for example, require a perfect profile of all 1s.[4]

Experience with the PULHES system has shown that while it does disqualify individuals with gross physical problems, it does not ensure that persons with the required profiles are physically fit enough to carry out their jobs.[5]

The ARIEM Physical Fitness System

According to the classification system developed by ARIEM, physical fitness is rated on two dimensions, strength and stamina. Strength is defined as the ability to lift a specified weight to a specified height. Stamina is defined as the ability to maintain a specified rate of energy expenditure over a specified time interval. The unit of measure for stamina is the kilocalorie (kcal) which is the energy required to raise one kilogram of water 1 degree

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[3]Jacobs, op cit., p 236.

[4]M. Binkin and I. Kyrialopolulos. Youth or experience? Manning the modern military. Washington, DC: The Brookings Institution, 1979.

[5]J. E. Wright and J. A. Vogel. Physiological demands of MOS clusters: Estimates and classification of army MOS fitness demands (undated report received December 1979). Natick, Massachusetts: US Army Research Institute for Environmental Medicine.

Celsius.[6] Each dimension is rated on a three point scale--high, medium, and low--with the lowest requirement being only that the individual complete the basic military training program.

Only two clusters require more than the baseline level of stamina, and these two also require high strength. These clusters are ALPHA, which requires high stamina and high strength, and BRAVO, which requires medium stamina and high strength. The remaining three clusters, CHARLIE, DELTA, and ECHO, have a strength requirement of high, medium and low, respectively, and a low stamina requirement. This results in an ordinal scale of physical fitness, with cluster ALPHA having the most stringent requirements. Table 1-1 shows the relationship of the five ARIEM clusters and the standards that define them.[7] The clusters were based on an analysis of the physical tasks included in a job description for each enlisted MOS. In some ARIEM reports, the medium and low strength clusters overlapped in the 23-30 kg region (51-66 lb.). Occasional lifting in this range would be a low strength demand, while regular lifting in this range would be a medium demand. To simplify the discussions, this report assumes 30 kg as the minimum value for the medium strength requirement. Exactly how strength will be measured has not been determined, but presumably it will be an isometric test that correlates with the ability to lift a compact box either to knuckle level (e.g., carrying a tool box) or to chest level (e.g., loading equipment onto an Army truck). The ARIEM stamina requirement is clearly defined and, consequently, should present no problem for testing.

An unpublished report provided by ARIEM explains how the clusters were developed:

> 3. The criteria used to group MOS with like or similar physical tasks was derived from the analysis of each MOS physical task, research of such documents as the National Health and Safety Act, and coordination with the US Army Research Institute of Environmental Medicine and proponent agencies and service schools.
>
> a. The classification of physical characteristics, such as muscular strength, muscular endurance, and circulo-respiratory endurance (stamina), is divided into high, medium, and low categories. Low (satisfactory) applies both to the baseline and MOS/SQT [training] programs, while medium and high apply to only the MOS/SQT program.
>
> b. Movement of weighted objects is classified as follows:
>
> (1) A weight to be lifted is considered light (low) when it weighs 66 pounds or less.
>
> (2) A weight to be lifted is considered medium when it weighs between 51 and 85 pounds.
>
> (3) A weight to be lifted is considered heavy (high) when it weighs 86 pounds or more.

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[6] R. J. Shephard. The energy requirements of work. Journal of Occupational Medicine, 1974, 16, 15-18.

[7] right and Vogel, op cit.

Table 1-1: The ARIEM Physical Demands Classification System[a]

Strength Standard (kg lift)	Stamina Standard (kcal/min) Low (0.0-7.4)	Medium (7.5-11.24)	High (11.25+)
High (39+)	CHARLIE	BRAVO	ALPHA
Medium (30-38)	DELTA		
Low (0-29)	ECHO		

[a]From J. E. Wright and J. A. Vogel. Physiological demands of MOS clusters: Estimates and classification of army MOS fitness demands (undated report received December 1979). Natick, Massachusetts: US Army Research Institute for Environmental Medicine.

c. Physical effort, such as carrying a heavy weight or marching, may be executed for short or longer distances. Likewise, a task may be accomplished in a short time or an extended time period. Depending upon the task, the amount of muscular endurance or stamina required to do the task is greater when the distance or time of execution is greater. For example, a task requiring the one-time lifting and carrying an object weighing 66 pounds for a short distance is less taxing physically than a task requiring the lifting and carrying of an an object weighing 51 pounds for long distances several hours a day. This accounts for the 16 pounds overlap between light and medium weight as explained in para 3b (1) and (2) above.

4. The criteria described above resulted in the cluster or group descriptions that follow.

a. The ALPHA cluster is designed to accommodate personnel whose MOS requires high fitness to execute demanding tasks. The physical requirement in this cluster is for high muscular strength, high muscular endurance, and high circulo-respiratory endurance (stamina) as specified below.

(1) A high degree of muscular strength and muscular endurance is required in the following:

(a) Lift, push, pull, carry, and support loads weighing 86 pounds and above for long distances and/or extended periods of time on a frequent basis.

(b) Dig for extended periods of time.

(2) A high degree of muscular strength, muscular endurance, and stamina is required to execute the walk/march, run, rush, dodge, jump, vault, climb, and crawl, as well as other movement techniques for prolonged periods of time.

b. The BRAVO cluster is designed to accommodate personnel whose MOS requires medium to high fitness to execute demanding tasks. The physical requirement in this cluster is for high muscular strength, high muscular endurance, and medium circulo-respiratory endurance (stamina) as specified below.

(1) A high degree of muscular strength and muscular endurance is required in the following:

(a) Lift, push, pull, carry, and support loads weighing 86 pounds and above for varying distances for extended periods of time on a frequent basis.

(b) Dig and chop for extended periods of time.

(2) A medium degree of stamina is required to execute the above physical tasks.

c. The CHARLIE cluster is designed to accommodate personnel whose MOS requires the movement of heavy loads. The physical requirement in this cluster is for high muscular strength, high muscular endurance, and low circulo-respiratory endurance (stamina) as specified below.

(1) A high degree of muscular strength and muscular endurance is required to lift, push, pull, carry, and support loads weighing 86 pounds and above for varying distances, periods of time, and frequencies.

(2) The requirement for stamina is minimal in the execution of the above tasks, thus requiring a low degree of circulo-respiratory endurance.

d. The DELTA cluster is designed to accommodate personnel whose MOS requires the movement of medium weighted loads. The physical requirement in this cluster is for medium muscular strength, medium muscular endurance, and low circulo-respiratory endurance as specified below.

(1) A medium degree of muscular strength and muscular endurance is required to lift, push, pull, carry, and support the following:

(a) Loads ranging in weight from 51 to 66 pounds for varying distances and periods of time on a frequent basis.

(b) Loads ranging in weight from 67 to 85 pounds for varying distances, periods of time, and frequencies.

(2) The requirement for stamina is minimal in the execution of the above tasks, thus requiring a low degree of circulo-respiratory endurance.

e. The Baseline (or ECHO) cluster is designed to accommodate personnel whose MOS requires the movement of light (low) weighted loads or no loads at all. The physical requirement in this cluster is for low muscular strength, low muscular endurance, and low circulo-respiratory endurance (stamina) as specified below.

(1) A low degree of muscular strength and muscular endurance is required to lift, push, pull, carry, and support the following:

(a) Loads weighing 50 pounds and below for varying distances, periods of time, and frequencies.

(b) Loads weighing 66 pounds and below for short distances and periods of time on an infrequent basis.

(2) The requirement for stamina is minimal in the execution of the above tasks, thus requiring a low degree of circulo-respiratory endurance.[8]

Most MOS were rated as having some physical demands, and a large percentage of the soldiers are in those jobs. According to the ARIEM assignment, over one-half of today's soldiers are in jobs that are supposed to require high strength, and over three-quarters are in jobs that are supposed to require at least medium strength. The studies reviewed in Chapter 2 show that many soldiers cannot currently meet the physical standards associated with their primary MOS. Therefore, if the proposed ARIEM physical standards are required for entry into the various MOS, the personnel available for critical MOS will be even further reduced.

[8] US Army Infantry School. MOS physical task list. Fort Benning, Georgia: October 1978, pp i-iii.

Chapter 2

LITERATURE REVIEW

In this chapter the ARIEM physical demands categories are considered as a personnel selection system and some of the problems that may be anticipated if it is used that way are analyzed. The rationale for selection systems in general is considered first. Then the problems of implementing strength and stamina as selection criteria are considered to develop a framework for discussion of the ARIEM system as a particular selection method. Three general kinds of problems can be identified: (1) the validity of the standards may be questionable, (2) the strength standards may be so high that insufficient personnel would be available for assignment, and (3) the stamina standards may be so low that they have no functional effect. The standards may also present a legal problem with regard to equal opportunity requirements.

Rationale for Selection Systems

Selection is one of three ways to match the worker and the job. The other two are to modify the job to fit the person through job design and to modify the person to fit the job through training. When gauged by on the job performance measures, selection of workers can often result in large productivity gains.[1] Unlike the proposed physical demands selection system, most of the selection systems the authors reviewed were based on psychological tests, application blanks or interviews. To be useful, a selection device must be validated, which basically means that some relationship between the selection criteria and job performance must be established. It can take many forms. A test that has a logical relationship between the selection criterion and the tasks required has Face Validity, a test of the actual job tasks or very similar ones has Content Validity, and a test that has a relationship between the selection criterion and some measure of performance has Predictive Validity.

Standards. Once the testing method has been validated, the next step is to determine how the method is to be used for job placement. Two general approaches to this problem can be distinguished:[2] the multiple cutoff method and the weighted score method. In the multiple cutoff or successive hurdle method, a person has to have an acceptable minimum score on all tests to be considered for selection. It assumes that persons below the minimum values on any of the tests could not successfully handle the job and thus should not be considered, regardless of other qualifications. In the weighted score or multiple correlation method, all of the scores are combined using a weighting scheme and those receiving the highest values are selected. It is based on the assumption that a low score on one test can be counterbalanced by a high score on another. The consequences on task performance of poor test performance in some area would determine which method would be acceptable.

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[1] R. M. Gagné and E. A. Fleishman. Psychology and human performance, New York: Holt, 1959, p 373.

[2] Ibid, pp 366-367.

Selection ratio. When setting testing standards, an important consideration is selection ratio which is the ratio of the number of positions open to the number of persons available to be assigned.[3] A high selection ratio means that almost everyone available for the positions must be used, while a low selection ratio means that only a few out of a great many candidates need to be chosen. Selection works best when the ratio is low because the cutoff scores on the test can be very stringent to provide the few individuals needed and these persons will be the "cream of the crop." Selection can be useful when the ratio is high if the cost of failure is also high. When the cost of failure is low (e.g., simply terminate the unsatisfactory employee and hire another person), only very low expenditure on selection may be appropriate.

Strength Tests

Physical strength in the physiological literature refers to the capability of an individual to exert force against an object. It differs from work in that its measurement does not require that the object which is being subjected to the force be moved. Pure measures of strength are called "isometric" because the length of the muscles stays constant.[4] When the force moves the object then work is performed. Maintaining a force isometrically, however, does not do work in a mechanical sense.[5] It should be clear that the popular conception of a strength test, weightlifting, involves both force and work, and therefore, is not a pure measure of strength.

When measured in actual tasks, strength and work are poorly correlated. This should not be surprising when one considers that when doing work the muscle length is constantly changing, as is the mechanical advantage produced by the relative position of the bones and joints.[6]

The validity of the ARIEM strength standards must be questioned because the measurement of strength is very task specific. In discussing the various studies of strength, a standard human factors guide makes the observation:

> As effective muscle-strength capability varies with sex, age, body size, physical conditions, motivation, and many other factors, the general data presented herein cannot be construed as universally valid. They are approximations only for their own groups. Furthermore, muscle strength is situation-specific; it varies within the same person according to body position, and up to now there is no single strength test in one position by which strength in other positions can be safely predicted.[7]

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[3] Ibid, p 364.

[4] K. H. E. Kroemer. Human strength: Terminology, measurement, and interpretation of data. Human Factors, 1970, 12, p 298.

[5] Ibid, p 298.

[6] Ibid, p 305.

[7] H. P. Van Cott and R. G. Kincade (eds.). Human engineering guide to equipment design (revised edition). Washington, DC: US Government Printing Office, 1972, p 543.

These caveats are especially applicable to some Army tasks such as removing parts of equipment which may involve awkward positions. Anyone who has ever tried to work overhead can appreciate the fact that the position for exertion can vary the force exerted by a ratio of 1:100.[8] There is a further question as to whether measurements taken in positions where maximum force can be exerted have any relationship to submaximal forces that normally would be required on the job. It is also true that conditions for exerting maximum force may not be the same as those for producing maximum work.[9] For example, a study with cranks found there was no significant correlation between "the amount of weight the operator can hold for a few seconds and the largest possible amount of energy he can transmit to the crank handle in the same time."[10]

Other physical abilities. There are numerous other physical abilities besides strength and work related to physical fitness. Fleishman, who has done a great deal of work in this area, has reached the conclusion: "There is no such thing as a general physical proficiency. The problem is a multi-dimensional one."[11] He has identified nine basic fitness factors based on two factor analytic studies of Navy recruits. Four of these factors related to strength and were defined as:

> EXPLOSIVE STRENGTH FACTOR: The ability to expend a maximum of energy in one or a series of explosive acts.
>
> STATIC STRENGTH FACTOR: The maximum force which a subject can exert, even for a brief period, where the force is exerted continuously up to this maximum.
>
> DYNAMIC STRENGTH FACTOR: The ability to exert muscular forces repeatedly or continuously over a period of time.
>
> TRUNK STRENGTH FACTOR: This is a second, more limited, dynamic strength factor specific to the trunk muscles, particularly the abdominal muscles.[12]

Fleishman's other five fitness factors are Stamina (which is covered in the next section), Extent Flexibility, Dynamic Flexibility, Gross Body Coordination, and Gross Body Equilibrium. According to him "any characterization of individual strength which ignores one or more of the four strength factors identified is incomplete."[13]

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[8] D. B. Chaffin. Human strength capability and low-back pain. Journal of Occupational Medicine, 1974, 16, 248-254.

[9] E. J. McCormick. Human factors engineering (3rd ed.). New York: McGraw-Hill, 1970, p 303.

[10] Ibid.

[11] E. A. Fleishman. The structure and measurement of physical fitness. Englewood Cliffs, New Jersey: Prentice-Hall, 1964, p 37.

[12] Ibid, pp 129-131.

[13] Ibid, p 149.

The ARIEM measures[14] would be incomplete in Fleishman's sense because they specify only one measure of strength--the ability to lift a specific weight. Nevertheless, the measures may be adequate because most of the high strength demands in military jobs are the result of lifting and carrying tasks.[15] This type of task probably involves a combination of the Dynamic Strength and Trunk Strength factors, since both the legs and upper body are involved in lifting.

Physical Fitness: Strength

In addition to the questions about strength in general as a selection criterion, there is a need to question the specific standards set by ARIEM. If these standards are set too high then the number of persons selected will not be enough to fill the positions requiring high physical fitness. If the standards are set too low, on the other hand, the personnel selected might not be able to carry out demanding physical tasks. In this section the proportion of persons able to meet the standards is estimated based upon published research data.

Maximum strength is determined in various ways. The psychophysical method requires the individual to adjust the weight of a container until it is almost too heavy to lift. Since the individual does lift the container, the psychophysical method is not a pure strength measure. It also involves risk of injury from overexertion. A second method is the isometric or static strength test in which the individual is required to exert the maximum force he or she can against a fixed handle attached to a force gauge. This method is relatively safe, but can give misleading results for lifting tasks because it does not take into account the fact that the position of body parts change during a lift. A third method, biomechanical modeling, attempts to overcome the limits of isometric testing by combining it with other physiological and anthropometry information to predict dynamic performance. Most of the studies with data relevant to the ARIEM standards have used either psychophysical or isometric methods.

In addition to the different methods to measure strength, there are also differences in lifting position and instructions from study to study. In some the individual is instructed to exert as much force as possible and even is encouraged to tolerate some pain. This method is intended to give maximum strength capacities which might relate to performance in either emergency situations or athletic competition. In another type of study, the individual is instructed to exert the largest amount of force that would be comfortable on the job. The values from these studies are intended to predict to the performance that might be expected of workers over an extended period of time.

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[14] J. E. Wright and J. A. Vogel. Physiological demands of MOS clusters: Estimates and classification of army MOS fitness demands (undated report received December 1979). Natick, Massachusetts: US Army Research Institute for Environmental Medicine.

[15] M. M. Ayoub, R. F. Powers, N. J. Bethea, B. K. Lambert, H. F. Martz, and G. M. Bakken. Establishing criteria for assigning personnel to air force jobs requiring heavy work (AMRL-TR-77-94). Wright-Patterson Air Force Base, Ohio: Aerospace Medical Research Laboratory, July 1978, p. 10.

Two studies were found in which males were required to lift weights to several heights. The findings of these studies provide some insight into how many soldiers might be able to meet the proposed ARIEM strength standards. In the first study by Emanuel and his colleagues[16] male Air Force personnel were required to lift the "maximum" weight of an ammunition case they could with both hands and place it on a platform at one of five heights. The platform heights were placed at 30 cm (1 ft.) intervals from 30 cm (1 ft.) to 152 cm (5 ft.) above the floor. The mean amount lifted ranged from 105 kg (231 lb.) to the lowest platform to 26.3 kg (58 lb.) to the highest one.

In the study by Switzer[17] male college students lifted a 30 x 30 x 15 cm (12 x 12 x 6 in.) box equipped with two handles. The students were told to lift a "reasonable" amount that "did not strain" them. The data were grouped by height and taller students were able to lift greater amounts to the same height. Switzer's middle group with an interval mean height of 175 cm (69 in.) is probably the most comparable to Emanuel, et al. They were able to lift a mean of 62.6 kg (138 lb.) to a height of 46 cm (1.5 ft.) but only able to lift 29.5 kg (65 lb.) to a height of 160 cm (5.25 ft.).

The mean weights lifted to each height from these two studies are shown in Figure 2-1. The one standard deviation range from the mean is shown by a "T" shaped line above and below the mean. Provided the data were normally distributed, 68% of the men's lifts would fall within this range. It is likely that the data were positively skewed (strung out toward the higher weights) in this type of experiment. This was verified by looking at the location of the 5th, 50th (median) and 95th percentiles given in the Emanuel et al. report. Except for the lowest height which showed a negative skew, there was a five to ten percent of the median greater range on the high half of the 90 percent confidence interval. Both because this does not seem to be much of a departure from normality and because Switzer did not report percentiles, the standard deviations were used to represent the dispersion of performance. The lower boundary of the ARIEM high and medium strength standards are shown by dashed horizontal lines. It is clear from the figure that the number of soldiers who would be able to pass a given standard is very much a function of the height of the lift. Up to a height of about 80 cm (32 in.) both studies indicate about 84% ($\underline{z} = 1.0$) or more of the male soldiers would be able to meet the minimum requirement for the high strength standard. For lifts above 115 cm (45 in.), both studies indicate that less than 50% ($\underline{z} = 0$) of the male soldiers are likely to be able to meet the minimum requirements for the high standard. ARIEM has not established what the lift height would be, but their MOS physical task inventories frequently mention loading equipment on a 2 1/2 ton Army truck. The bed of this type of truck is 137 cm (4.5 ft.) from the ground when parked on a level surface. This lift height is indicated by the vertical dashed line in Figure 2-1. Both studies show that only about 16% ($\underline{z} = -1.0$) of the male soldiers would be able to lift the

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[16] I. Emanuel, J. W. Chaffee, and J. Wing. A study of human weight lifting capabilities for loading ammunition into the F-86H aircraft (WADC-TR-56-367). Wright-Patterson Air Force Base, Ohio: Wright Air Development Center, August 1956.

[17] S. A. Switzer. Weight-lifting capabilities of a selected sample of human males (MRL-TDR-62-57). Wright-Patterson Air Force Base, Ohio: Aerospace Medical Research Laboratories, June 1962.

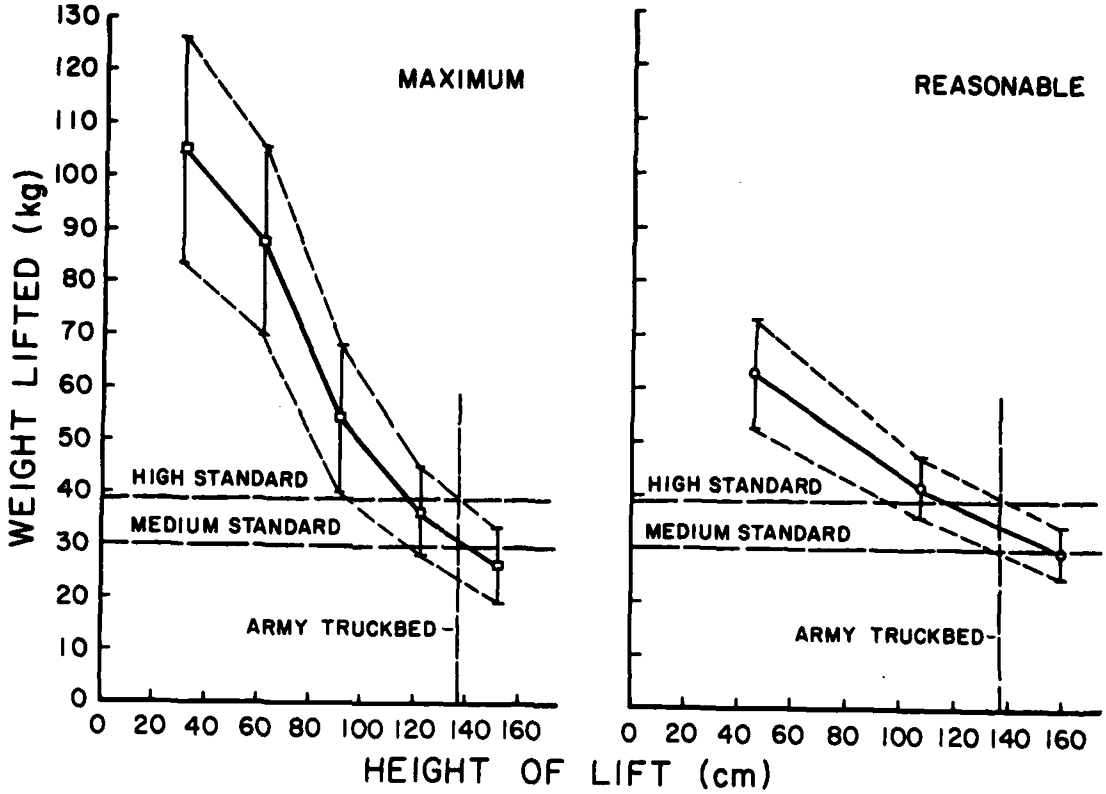

Figure 2-1. Mean "Maximum"[a] and "Reasonable"[b] weights lifted to various heights by males (standard deviations are indicated by "T"s).

[a]From I. Emanuel, J. W. Chaffee, and J. Wing. A study of human weight lifting capabilities for loading ammunition into the F-86H aircraft (WADC-TR-56-367). Wright-Patterson Air Force Base, Ohio: Wright Air Development Center, August 1956.

[b]From S. A. Switzer. Weight-lifting capabilities of a selected sample of human males (MRL-TRD-62-57). Wright-Patterson Air Force Base, Ohio: Aerospace Medical Research Laboratories, June 1962.

high standard to that height. The two studies give different predictions for the medium standard. Under "maximum" lift instructions, the figure indicates about 60% (z = .25) would be able to pass while "reasonable" lift instructions indicate about 80% (z = .85) would. It is not at all clear why the instructions should have reversed effects at low and high lifts. This is just another example of how difficult it is to predict how individuals will perform from one strength task to another. What is clear is that a sizable proportion of the male soldiers would find the high strength standard difficult to meet and a moderate proportion would have difficulty with the medium standard. If the standard were only to lift the required weight to knuckle height, 76 cm (30 in.), then well over 90% (z = 1.3) of the male soldiers could probably pass either standard.

Much less information exists on the maximum lifting ability of females. Typically, their upper body strength has been reported to be about 60% that of males.[18] If this is the case, then very few female soldiers would be able to pass even the medium strength standard if 137 cm were the required height. While some of this strength difference can be attributed to difference in size of women and men, there is clear evidence that women, for their size, have less upper body strength than men but about equal leg strength.[19,20] This typically is manifested in physical fitness tests by the inability of a woman to do more than one or two pullups though she is fit by other standards.[21]

The strength standards proposed by ARIEM are not definite enough to predict their consequences on personnel selection. If the interpretation is a test equivalent to lifting a box to knuckle height, then very few individuals would fail to meet even the high strength standard. If the interpretation is for a lift to truckbed height, however, then a sizable proportion of the men and almost all of the women would not "pass" the high standard. In all likelihood, the strength standard will have an impact on the number of persons available to assign to various jobs.

Physical Fitness: Stamina

Stamina, or the more technical term, aerobic power, is the ability of an individual to do sustained physical work. It contrasts with physical strength which is measured in terms of the force exerted isometrically in a static test. Stamina must be measured while the individual engages in some difficult

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[18]S. H. Snook and V. M. Ciriello. Maximum weights and work loads acceptable to female workers. Journal of Occupational Medicine, 1974, 16, 527-534.

[19]C. D. Johnson, B. H. Cory, R. W. Day, and L. W. Oliver. Women content in the army - REFORGER 77 (REF WAC 77) (ARI-SR-S-7). Alexandria, Virginia: US Army Research Institute for the Behavioral and Social Sciences, May 1978.

[20]J. A. Peterson, J. A. Vogel, D. M. Koval, and L. F. Tomasi. Project 60: A comparison of two types of physical training programs on the performance of 16-18 year-old women. West Point, New York: US Military Academy, May 1976.

[21]Fleishman, op cit., p 120.

activity such as walking on a treadmill or riding an ergometer (i.e., a stationary bicycle).[22] The physical fitness test which most closely correlates with stamina is the long distance run.[23] Individuals high in stamina are generally able to work hard over continued periods without becoming fatigued and are thought to be less susceptible to heart attacks.[24] As a measure of energy expenditure, stamina can be expressed in kilocalories per minute (kcal/min). Other measures of stamina are oxygen uptake and ventilation volume.[25]

Standards. The standards for stamina proposed by ARIEM--11.25 kcal/min for the high clusters and 7.50 kcal/min for the medium clusters, respectively--apparently can be met by almost all soldiers, male or female, after a good conditioning regimen such as basic training. Since no selection problems are anticipated as a consequence of implementing the stamina standards, the reader may omit the following review of the methods of measuring stamina and research findings that support this conclusion and skip to the section titled "Selection Ratios" without losing continuity.

Methods of measuring stamina. Energy expenditure can be calculated directly by measuring the temperature change within an insulated container of known volume while a person or animal engages in work. This method, called direct calorimetry, while very accurate is not suitable for most purposes. A method which is almost as accurate, indirect calorimetry, takes advantage of the fact that the combustion of a specific amount of a specific type of food always takes a fixed amount of oxygen. To measure this oxygen, the individual to be measured wears a breathing mask which is connected to equipment that analyzes the gas content of the expired air. Although some elaborate equipment is required, indirect calorimetry is much easier to implement than direct. Under good conditions, it agrees with direct calorimetry to within one or two percent. The different amounts of oxygen required to burn different types of food need to be taken into account for the highest precision, but for practical work the approximation of five kcal to one liter of oxygen is usually used.[26] In this report, oxygen uptake is referred to as VO(2). Other methods of estimating work are the pulse rate[27] and ventilation volume.[28] Both of these measures are linearly related to oxygen consumption over

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[22] R. J. Shephard. The energy requirements of work. Journal of Occupational Medicine, 1974, 16, 15-18.

[23] Fleishman, op cit., p 131.

[24] J. F. Patton and J. A. Vogel. An evaluation of physical fitness in the "pro-life" program, 2d infantry division, Korea. Natick, Massachusetts: US Army Research Institute for Environmental Medicine, 1976.

[25] Shephard, op cit.

[26] Ibid.

[27] R. B. Andrews. Estimation of values of energy expenditure rate from observed values of heart rate. Human Factors, 1967, 9, 581-586.

[28] M. E. Maxfield and P. E. Smith. Abbreviated methods for the measurement of oxygen consumption in work physiology. Human Factors, 1967, 9, 587-594.

limited ranges. The pulse rate gives the best estimates of work when the person is working at from 50% to 100% of maximum power. Ventilation volume, on the other hand, is best when the person is working at between 10% and 50% of maximum power.[29] The pulse rate measure is particularly valuable when the person must stay on the job and move about freely. It can be measured with small electrodes and a portable telemetry unit carried by the individual. Unfortunately, the amount of work done in job situations is not usually high enough to be in the range for best estimation from pulse rate. In the studies reviewed for this report, stamina was measured by every method except direct calorimetry.

Comparison among studies is sometimes difficult because the results are reported in terms of different units. There is also an additional problem of whether the results are given in absolute power or in terms of power per unit body weight. The absolute measure gives the highest values for large, physically fit individuals such as football linemen, while the relative measure gives the highest values for lean, physically fit individuals such as long distance runners. The choice of reporting method is not clear, even though it might be argued--as it is with strength--that a job requires a fixed amount of work to be done, regardless of the size of the person doing it. This is not quite true because in the typical task requiring high stamina, the largest part of the physical work is done to move the body's own weight quickly which requires less energy expenditure for a smaller individual. Since the ARIEM standards have been developed in terms of absolute units, all of the units in the studies have been converted into the absolute values of kcal/min. In some cases, this had to be estimated because work capacity was given in relative terms (e.g., VO(2) of ml/kg/min) and weights were not given for the individuals studies. In these cases, the absolute estimates were made using a mean male weight of 72.23 kg and a mean female weight of 59.97 kg.[30] Conversion of other work units (e.g., foot-pounds, watts, or horse power) was done using standard conversion factors.[31] (The conversion factors are listed in Appendix B.)

Stamina measurements. The maximum work capacity depends on what the task is and how long it is done. Champion athletes using rotary pedaling apparatus have achieved stamina levels up to 64 kcal/min for single movements of less than one second in duration. Brief bursts can produce from 5.35 to 21.4 kcal/min. Moderately long steady state exertion up to 2.5 hours produces from 4.30 to 5.35 kcal/min, and long term tests produce up to 2.15 kcal/min. These are maximum figures which the authors recommend should be reduced by 20% to 30% for ordinary healthy men and about twice that amount for women.[32] These findings indicate that even extremely fit individuals cannot maintain stamina levels above 5 kcal/min for much more than two hours.

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[29]Shephard, op cit.

[30]R. M. White. The anthropometry of United States army men and women: 1946-1977. Human Factors, 1979, 21, 473-482.

[31]J. Robson. Basic tables in physics. New York: McGraw-Hill, 1967.

[32]Van Cott and Kinkade, op cit., p 574.

Normative data. Various values for the aerobic capacity of military personnel have been reported. In the "pro-life" test conducted in Korea, Army men had a mean initial stamina level of 17.5 kcal/min and an average level of 19.5 kcal/min after six months of extensive physical training.[33] Men measured before and after basic training went from a mean level of 17.1 kcal/min to 19.3 kcal/min (both values estimated from mean body weights).[34] This is a gain comparable to that found in the previous study. Kowal and his associates tested the fitness of older Army men and found that they were more fit than the general population. Their group selected for high fitness showed a mean level of 17.2 kcal/min.[35] A test of 74 British soldiers estimated their maximum mean stamina level was 15.2 kcal/min or 16.3 kcal/min, depending on whether a cycle test or a step test was used for measurement.[36] The two stamina measures were moderately correlated, $r = .65$. Sedentary male college faculty, 30 years of age or younger, showed mean stamina values of 15.9 kcal/min estimated from work at a heart rate of 160 beats/min.[37] Professional fire fighters in this age group showed a mean stamina level of 17.5 kcal/min. They were somewhat heavier than the Army men--a mean of 81.2 kg--compared with the Army mean of 72.2.[38] These various studies point to a maximum value between 16.3 and 17.5 kcal/min as a reasonable estimate of the stamina of the male soldier. The SDs, when given, were about 2.5 kcal/min. The ARIEM standards list 11.25 kcal/min for the highest requirement. Assuming the lower estimate for male stamina of 16.3 kcal/min, 96% ($z = 2.0$) of the males would be predicted to meet the high requirement without training.

There was not as much data found on females' work capacity. Kowal and his associates[39] found females had a mean stamina value of 12.6 kcal/min

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[33] Patton and Vogel, op cit.

[34] D. M. Kowal, J. F. Patton, and J. A. Vogel. Psychological states and aerobic fitness of male and female recruits before and after basic training. Aviation, Space, and Environmental Medicine, 1978, 49, 603-606.

[35] D. Kowal, J. Paris, J. Hodgon, and J. Vogel. Exercise tolerance, coronary risk factors, and aerobic capacity of older military personnel. The Physician and Sportsmedicine, 1978, 6(12), 6 pp.

[36] A. F. Amor and J. A. Vogel. Comparison of the stamina tests of the army physical fitness assessment (APFA) scheme and the APRE physical fitness survey (APRE 9/74). Farnborough Hants, England: Army Personnel Research Establishment, April 1976.

[37] A. E. Coleman, C. L. Burford, and P. Kreuzer. Aerobic capacity of relatively sedentary males. Journal of Occupational Medicine, 1973, 15, 628-632.

[38] P. W. R. Lemon, M. K. Hermiston, and R. T. Hermiston. Physiological profile of professional fire fighters. Journal of Occupational Medicine, 1977, 19, 337-340.

[39] Kowal, Patton, and Vogel, op cit.

before basic training and 12.4 kcal/min afterwards (values estimated from average female body weights). This was in sharp contrast to the improvement shown by males in basic training. They attributed this to the poor fitness training that was being given women at the time the data were collected. The women's training was subsequently revised to a regimen similar to the men's. A study of physically active high school women done for the US Military Academy to evaluate female cadet responses to fitness training showed stamina improved from a mean 12.1 kcal/min before training to a 12.8 kcal/min after.[40] This study indicated a suitable training program can increase women's stamina. Another study estimated mean maximal stamina was 12.6 kcal/min for college women working over a whole day,[41,42] a stamina of 12.7 kcal/min, which is in closer agreement with the first two studies cited. The SD for women was 1.63 kcal/min. These data suggest that women's aerobic power is about 70% of men's. Based on these estimates, about 80% (mean = 1.63, z = .97) of the women would be fit for the highest stamina requirement, while well over 99% (z = 3.47) could meet the medium stamina requirement. It should be noted that some of the stamina difference between men and women is related to body weight. If the results were put in the measure VO(2) of ml/kg/min as many authors do, then the females would have 87% (z = 1.17) of male aerobic capacity.

With a good basic military training program, nearly all new soldiers, male or female, should be able to meet the medium stamina requirements proposed by ARIEM. Given the difficulty of measuring this value accurately without using indirect calorimetry which is elaborate and time consuming, it is not clear what value the stamina requirement has. It might be used to screen out persons with cardiac problems, but the current physical examination probably does this just as well. Furthermore, it is not clear that any Army jobs would approach the maximum stamina level of 11.25 kcal/min. A study in an aluminum smelter showed the heaviest tasks measured there were using a jack hammer which gave a stamina level of 7.25 kcal/min over a period of three minutes and removing a cover over the pots which gave a level of 7.10 kcal/min over a period of four minutes.[43] It is doubtful that any peacetime Army job requires the level of exertion proposed by ARIEM, and so to maintain the fitness to perform at wartime level would require extensive physical training for all MOS, regardless of the stamina cluster. Industrial studies bear out this conclusion because it has been found that there is very little stamina difference measured between workers in heavy manual labor and sedentary office workers.[44]

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[40] Peterson, Vogel, Koval, and Tomasi, op cit.

[41] M. G. Wardle. Women and strength work. Human Factors, 1977, 19, 515-517.

[42] M. G. Wardle. Women's physiological reactions to physically demanding work. Psychology of Women Quarterly, 1976, 1, 151-159.

[43] P. B. Raven, M. O. Cowell, B. L. Drinkwater, and S. M. Horvath. Indirect calorimetric estimation of specific tasks of aluminum smelter workers. Journal of Occupational Medicine, 1973, 15, 894-898.

[44] Shephard, op cit.

Chapter 3

PERSONNEL ASSIGNMENT PROBLEMS CREATED BY PHYSICAL DEMANDS STANDARDS

Implementation of the ARIEM physical demands criteria as they stand is likely to cause a shortfall in personnel in some MOS.

Selection Ratio

A large number of MOS fall in fitness clusters that have above baseline strength standards. As Table 3-1 shows, almost 55% of the Army's people are assigned to jobs in clusters that have a high strength requirement (i.e., ALPHA, BRAVO, and CHARLIE). This results in a selection ratio of slightly more than 1:2 for the high strength cluster jobs. If only 60% of the entering soldiers could meet the "high" strength standard, there will barely be enough people to fill those positions; a possibility that could occur if the interpretations made in the section "Physical Fitness: Strength" (Chapter 2) are correct. It is always possible to obtain sufficient people by relaxing the standard, of course, but if almost anyone can pass a standard it is questionable whether it serves any functional purpose. Even if the necessary 55% of the new soldiers can pass the high standard, the assignment problems still would not be solved. Other factors also must be considered such as availability for assignment and the soldier's training preference. Even less favorable selection ratios would apply for the "medium" strength standard, since over 76% of the positions are in MOS having at least that requirement.

Multiple selection criteria. Many MOS have other selection hurdles besides physical fitness such as visual acuity, color vision, security clearance, or high test scores in specific aptitude areas. These other requirements complicate selection for physical demands. In particular, many of the modern Army's jobs are in technical areas which require high mental aptitudes. While it is difficult to compare specific test scores on different aptitude tests across MOS, some general idea of the aptitude required for a job can be gained from the relationship with scores on the Armed Forces Qualification Test (AFQT) which is a general aptitude test battery given to all soldiers when they come into the service. Extensive research was done during World War II on the predictive validity of the forerunners to this test battery. Success in training was found to correlate highly with the test scores for a broad range of skilled jobs.[1] It seems reasonable to assume, therefore, that the general mental ability as measured by the AFQT is one of the important determinants of job success.

When more than one selection criterion is implemented, such as the combination of a strength and aptitude requirement for a technical MOS, a kind of

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[1]Staff, Personnel Research Section, US Army. The army general classification test. In J. J. Jenkins and D. G. Paterson (eds.), Studies in individual differences. New York: Appleton-Century-Crofts, 1961. (Reprinted from Psychological Bulletin, 1945, 42, 760-768.)

Table 3-1: Percentage of Enlisted Personnel Falling in ARIEM Cluster[a,b]

Cluster	Percentage in Cluster	Percentage at or Above Cluster	Nr. MOS in Cluster
ALPHA	20.24	20.24	10
BRAVO	12.90	33.14	39
CHARLIE	21.56	54.70	62
DELTA	21.79	76.49	53
ECHO	23.51	100.00	170

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[a]J. E. Wright and J. A. Vogel. Physiological demands of MOS clusters: Estimates and classification of army MOS fitness demands (undated report received December 1979). Natick, Massachusetts: US Army Research Institute for Environmental Medicine.

[b]Defense Department Data Center (DMDC) files dated September 1978.

double bind can result. First, the soldiers who can meet the strength requirement standards are selected out of the pool of available personnel for MOS with obvious physical demands such as infantry. This leaves a pool with a smaller proportion of strong individuals from which the Army must select personnel who are both strong and bright to fill many of its technical specialties. In this situation, technical jobs may not be filled (or filled by personnel who are not qualified) because of the strength standards. This is likely to be the case if a large proportion of the jobs have selection requirements (i.e., a high selection ratio). Under these conditions, it is highly unlikely that all of the selection requirements can ever be met.

To avoid the double bind, MOS which require high mental aptitude and are categorized as physically demanding should be analyzed to determine whether the high physical fitness standards are absolutely necessary. It appears that there are many such critical MOS, although there is no easy way of knowing which ones they are because the peacetime Army lets many soldiers select their own training. One way to identify the MOS with high aptitude requirements is to look at the average AFQT scores of the incumbents. This assumption that the average AFQT score reflects job requirements is supported by examination of the MOS descriptions at various levels of mean AFQT scores. The highest AFQT means are found in the intelligence and technical specialties, while the lowest fall in the supply specialties. Combat Arms MOS fall at or near the 50th percentile, indicating the unselected nature of the incumbents.

The relationship of the ARIEM strength requirements to the average AFQT scores in MOS clusters is shown in Table 3-2. Data from females were not included because their test scores were much higher, probably the result of the Army's previous policy of accepting only women whose AFQT score was above the 50th percentile. The breakdown in the table shows that strength clusters are relatively unrelated to mean aptitude levels. Many MOS apparently require both strength and mental ability, as indicated by the entries in the upper left hand portion of the table.

Some relief could be obtained by lowering the criteria to a point where sufficient personnel were available, but there would still be shortages, especially in many highly technical or otherwise intellectually demanding jobs. Yet, to abandon the concept of physical selection would be a failure to solve the original problem that the requirements were designed to address--that there are jobs in the Army that require high levels of fitness to accomplish. To reach a solution requires a closer look at both the requirements of the MOS and a closer look at the abilities of the individual soldiers.

Examining requirements. The simplest way to get more people from a selection procedure is to reduce the standards. This could be the appropriate action if the standards are too high or only slightly correlate with job performance. Some research does suggest that ARIEM has set the strength requirements too high. An Air Force survey asked personnel in four specialties to rate how often they lifted various categories of weights. The researchers used a five-point scale ranging from "seldom or never" on the low end to "almost constantly" on the high. In the two electronic specialties surveyed, 12% reported they lifted loads of 28 kg (61 lb.) or greater "more than occasionally" which was the midpoint of the scale, while in the two

Table 3-2: Percentage of Male Soldiers in Each ARIEM Strength Cluster as a Function of the Average AFQT Percentile for the MOS[a,b]

Mean AFQT for MOS	Nr. MOS	Nr. Soldiers	Strength Standard: Low	Medium	High
65 -	119	37,943	48.4	25.8	25.7
60 - 64	52	55,062	22.6	8.1	69.4
55 - 59	58	66,535	34.7	13.5	51.7
50 - 54	67	213,565	10.0	15.2	74.7
45 - 49	37	151,550	14.2	38.1	47.7
- 44	22	52,837	61.6	14.3	24.2
TOTAL	355	577,492	22.4	21.0	56.6

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[a]J. E. Wright and J. A. Vogel. Physiological demands of MOS clusters: Estimates and classification of army MOS fitness demands (undated report received December 1979). Natick, Massachusetts: US Army Research Institute for Environmental Medicine.

[b]Defense Department Data Center (DMDC) files dated September 1978.

materials handling specialties surveyed, 45% gave this response.[2] This represents a considerably greater amount of heavy lifting than occurs in comparable civilian jobs. One possibility is that the respondents in the Air Force survey overestimated the amount of heavy lifting required. Such over-reporting of the physical demands of an MOS could be corrected with a careful job analysis by a trained observer. The observer would make more realistic estimates of physical requirements by specifically stating what is lifted, how high, how often, and as a part of what tasks. Such specificity always must be one of the first steps in a job analysis.

Another way to increase the number of people meeting the requirements is to make them specific to the demands of the job. General categories such as those proposed by ARIEM create a situation in which many jobs compete for individuals with the same abilities. The pool of qualified personnel can be expanded considerably if the test conditions are modified to specific task requirements (e.g., lifting a specified type of weight to a specified height using a specified method of lifting).

For those MOS for which the strength standards can be reduced or modified, the pool of qualified personnel can usually be greatly expanded by the inclusion of women. They are much more likely to be screened out by strength requirements but are about as likely as men to possess other important abilities.

Job modification and related adjustments. The selection problem for some jobs can be eased by making minor modifications in the task requirements. For example, two people instead of one could be assigned to carry a heavy object, or a task could be one in a way that did not require a part to be lifted to a high work bench. In combination with other adjustments, task modification could greatly increase the pool of qualified personnel.

In many ways, the problems of selecting people on the basis of physical abilities parallel the problems of selecting handicapped people for jobs in industry. Hanman[3] analyzed the problem of job placement for disabled workers in both Europe and the United States and developed an approach that could be applied to selection on the basis of physical fitness. He notes that the concept of a disabled worker is a relative one. When one looks at the full spectrum of jobs, probably not more than 1% of workers could qualify for every job in every way. In other words, almost everyone is "disabled occupationally" for some jobs. There are basically four ways to place people who are limited in what they do: "(1) match the worker with the job, (2) change the worker to fit the job, (3) change the job to fit the worker, and (4) change both the worker and the job to suit each other."[4] It is the work of the analyst to determine the requirements of the job. This analysis requires

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[2] K. G. Koym. Development of physical demand profiles for four airman career ladders (AFHRL-TR-75-67). Brooks Air Force Base, Texas: Air Force Human Resources Laboratory, November 1975.

[3] B. Hanman. Physical capacities and job placement. Stockholm: Nordisk Rotogravyr, 1951.

[4] Ibid, p. 15.

three parts: (1) identify the job, (2) describe it in terms of separate tasks, which are the smallest functional units of the job, and (3) determine the requirements for successful performance of these tasks. Hanman points out that in jobs for which disabled workers are qualified, they perform "just as well or just as poorly as other, nondisabled workers."[5]

Most personnel selection procedures have treated the disabled worker as a special case to be handled outside normal placement channels. Hiring of such individuals was seen as more of an act of charity than as a method of obtaining an employee. The usual method was the disability approach. First, it was observed that disabled people may be classified conveniently into various disability groups, such as the one-armed, one-eyed, and the one-legged. Then the question was asked: Why is it not also possible to classify jobs into corresponding groups which will allow for the limitations of workers in the respective disability groups? If this can be done, then it would follow that the one-armed man, for example, could be placed on any job listed for one-armed workers, providing he also possessed the skills for the job.[6] Hanman sees this as wasteful of human resources for three reasons: (1) jobs are not all the same in terms of demands even if they have the same name, (2) people with the same disability do not have the same capacity, and (3) the approach is a negative one based on disabilities rather than abilities. Another class of selection systems using ratings is also used. These systems try to deal with abilities rather than disabilities. Jobs are rated on scales such as light, medium or heavy, while the worker is rated for suitability on a similar scale. The Army's PULHES system discussed in Chapter 1 is an example of a rating system. Hanman sees the problems for the rating systems stemming from a lack of agreement between observers in how to rate both jobs and individuals. What constitutes "light work" for one judge may be rated as "medium work" by another. Similar ambiguities can develop in rating individuals.

As an alternative, Hanman advocates what he calls the specific method which focuses first on the abilities of the worker. It does this in terms of the individual worker and the specific job. Qualifications and requirements are based on specific tasks on the job and specific abilities of the worker, rather than ratings. The necessity on each task has to be reviewed carefully. The job analyst must look at each task separately asking the question: "Is it really necessary to do the task in the demanding manner described, or could the task be accomplished satisfactorily in another, less demanding way?" The answer to this question must consider the total job situation, including such things as the tasks of other workers on the job, the physical characteristics of the location and possible variations in the tasks required of the worker. In some ways, the ARIEM physical demands system meets Hanman's definition of the specific method, but it fails to give exact specification of the tasks when defining standards.

Field experience with women. A serious problem with applying a civilian job placement model to the Army is the need for interchangeability of persons with the same job classification. In an emergency there will not be time to make adjustments for someone who is not able to carry out all aspects of the

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[5] Ibid, pp 59-60.

[6] Ibid, pp 69-70.

MOS, such as heavy lifting. The best information on the magnitude of this problem comes from two studies which evaluated the impact of women in Army units. Because women are smaller and weaker on the average than men, these tests involved soldiers who were not as likely to be able to meet the minimum strength requirements. Failure to meet operational requirements by units with a large percentage of women would be good evidence for the necessity of strength requirements. If some of the units did meet operational goals with large percentages of women, the way the females in physically demanding MOS carried out their duties would suggest ways to modify the tasks.

The first test was called Maximum Women's Army Corps (MAX WAC) (1977) and involved companies with 0%, 15% or 35% enlisted women participating in a 72-hour modified Army Training and Evaluation Program (ARTEP).[7] In this exercise, the scenario was known in advance and command decisions did not affect the outcome, so it became a test of how well the low-level units were able to perform their functions under field conditions. The basic finding was that there were no differences in performance among the units with various percentages of women. One explanation offered in the report was that "Enlisted women accomplished physically demanding tasks by utilizing leverage and a peer helper when required."[8]

The MAX WAC exercise tested medical, military police, maintenance, signal, and transportation companies. In the medical companies the women experienced difficulties in loading litter patients into ambulances or in performing long carries. A mix of male and female members in the teams solved this problem. Most of the tasks involved a team and these were satisfactorily accomplished. The military police companies had no problems with women, which parallels the findings of research done on women in civilian police departments.[9,10] The observers stated that the women in maintenance companies did as well as the men, including performance on the tasks of changing tires and operating wrecker vehicles. The only problem for women in the signal companies was manually starting a cold 10 kilowatt generator. This was an obviously demanding task, but also one that might be helped by a mechanical aid. The loading and unloading of supplies was observed to be a difficulty for women in the transportation companies. Some of the difficulty for this task could be reduced with mechanical aids. Overall, the lack of physical strength for the enlisted women was compensated for by sharing tasks or taking slightly longer to carry them out. Neither of these solutions was observed to degrade unit performance.

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[7] US Army Research Institute for the Behavioral and Social Sciences. Women content in units: Force development test MAX WAC). Alexandria, Virginia: October 1977.

[8] Ibid, p I-3.

[9] P. H. Bloch and D. Anderson. Police women on patrol: Final report. Washington, DC: Police Foundation, 1974.

[10] C. Milton. Women in policing. Washington, DC: Police Foundation, 1972.

A longer test of women's ability to operate in the field was made as part of the annual Return of Forces to Germany (REF WAC 77) exercise.[11] No special assignments of women were made on this exercise, but comparable companies were observed which were matched except for the content of women. The researchers found that the:

> results support a conclusion that 10% women has a negligible impact on unit performance in a 10 day field exercise for the types of companies tested. Of the 90 Military Occupational Specialties in the 27 participating units 18 were designated as being physically too demanding for women by 50% or more officers or NCO supervisors.[12]

The report listed only eight MOS that the NCO data collectors would not recommend for women. The ARIEM clusters for these MOS are given in Table 3-3. One specialty, military police (91B), had no physical demand problems for women, but was included because the observers felt the women were insufficiently trained to do the job. Another, infantryman, was closed to women and was not discussed in the report. This MOS, 11B, is in the ALPHA cluster, high strength and stamina, and clearly deserves that classification. The results of REF WAC 77 substantially replicated the findings of MAX WAC in that very few MOS require that all personnel have large amounts of strength or stamina. Of the six MOS open to women which were reported as presenting problems because of the physical strength required, only two were classified as requiring high strength by ARIEM (i.e., 63H and 91B). A larger overlap with the ARIEM clusters would be expected to have occurred if the MOS were selected at random (i.e., 55%).

Other Benefits

Besides reducing the selection problem of filling MOS with high physical demands, a systematic physical demands job analysis and job modification program would have the additional benefits of showing ways to reduce the number of job-related disabilities and to reduce the potential for a successful discrimination suit based on sexual or racial grounds.

Low back pain is a major industrial medical problem that can be traced primarily to overexertion.[13] The incidence is eight times greater for workers on jobs requiring high lifting strength compared with workers on jobs requiring little or no lifting. In fact, materials handling is the most hazardous act in industry. A great amount of time is lost from the job because of low back pain, and it ranks as the eleventh reason for the total days spent in the hospital in the United States. According to Chaffin:

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[11] C. D. Johnson, B. H. Cory, R. W. Day, and L. W. Oliver. Women content in the army - REFORGER 77 (REF WAC 77) (ARI-SR-S-7). Alexandria, Virginia: US Army Research Institute for the Behavioral and Social Sciences, May 1978.

[12] Ibid.

[13] D. B. Chaffin. Human strength capability and low-back pain. Journal of Occupational Medicine, 1974, 16, 248-254.

Table 3-3: MOS Found Unsuitable for Women in REF WAC 77[a]

MOS	Title	ARIEM Classification
11B	Infantryman[b]	ALPHA
63H	Automotive repairman	CHARLIE
64C	Motor transportation operator/driver	DELTA
76W	Petroleum supply specialist	DELTA
76X	Subsistence supply specialist	DELTA
91B	Medical specialist	ALPHA
94B	Food service specialist	ECHO
95B	Military police[c]	CHARLIE

[a]Adapted from C. D. Johnson, B. H. Cory, R. W. Day, and L. W. Oliver. Women content in the army - REFORGER 77 (REF WAC) (ARI-SR-S-7). Alexandria, Virginia: US Army Research Institute for the Behavioral and Social Sciences, May 1978; and J. E. Wright and J. A. Vogel. Physiological demands of MOS clusters: Estimates and classification of army MOS fitness demands (undated report received December 1979). Natick, Massachusetts: US Army Research Institute for Environmental Medicine.

[b]Not open to women.

[c]Not suitable because women lacked training.

more engineering concern must be given to creating effective means for eliminating man as a material handler. In the interim, however, it may be possible to reduce the incidence and severity of low-back problems by more careful selection of people for those jobs still requiring manual materials handling.[14]

Chaffin's study uses what he calls the Lifting Strength Rating, which is the ratio of the maximum weight lifted by the worker to that predicted for a large, strong man doing the same type of lift. The incidence of low back pain was highest in those jobs where the ratio was close to 1.0. This meant the person had little reserve capability and consequently was overstressed. His tables indicated that the medium ARIEM requirement would produce a Lifting Strength Rating close to 1.0 for average males, so the Army might well have problems with back injuries. By limiting the number of jobs having high physical demands using the job analysis and modification program discussed here, the Army will be able to highly select those few individuals needed for demanding jobs. This should reduce the incidence of low back pain and other physical stress injuries with a consequent savings in time lost and medical costs.

Potential Legal Difficulties

Implementation of the physical demands requirements would mean that a large proportion of the Army's women would not be eligible for those positions requiring medium or high strength. To the extent that strength is correlated with weight or stature, these requirements might also exclude a substantial number of individuals from certain etchnic groups which are, on the average, smaller than white males. (No specific data were available on this issue.) Up to now, discrimination based on physical requirements has centered on height and weight standards. In the US, courts have required that the standards be neutral with regard to sex and that they must be based on real and not imagined job demands. A discussion of the potential impact of the Equal Rights Amendment on the military, by Carole L. Frings, Office of the General Counsel, Office of the Secretary of Defense, clarifies the meaning of neutral.

> The services would have to establish neutral standards, and based on those, any man or woman who was strong enough and otherwise qualified to perform the tasks required of that type of duty, would be allowed to do so. Under this system, for example, if any particular women [sic] were strong enough to carry a rifle and a pack many miles across country, she could become a combat infantryman, assuming she met the neutral minimum physical and other standards set up for that type of duty. I would like to stress that the physical standards would have to be neutral as to sex, that is, they must be based on the actual physical and other qualifications functionally necessary to perform that task. For example, the standard could not require that all applicants weigh at least

[14]Chaffin, op cit.

165 lbs. and be at least 5'10", unless those attributes were actually necessary to perform such a duty. Obviously, such a standard would automatically bar most women from qualifying.[15]

The key phrase here is "functionally necessary to perform that task." This would mean that there was no alternative to perform a task except by brute strength. Put in testing terms, "functionally necessary" means that one must demonstrate content validity. Face validity and even predictive (empirical) validity would be insufficient to meet the legal requirements.

Because of the extensive litigation in the area, it is useful to examine how minimum height and weight standards as a form of sex discrimination have been viewed by the courts. The following discussion is based on a review of such decisions by Callis[16] who is with the California Department of Labor.

Even when height and weight requirements are neutrally applied, they have been attacked as a covert form of sex discrimination because they exclude a disproportionate number of women. Cases have been brought under either the Equal Protective Theory or under Title VII of the Civil Rights Act of 1964. The strongest case can be made under Title VII, but it requires that all administrative remedies be exhausted first. Under Title VII, sex discrimination is prohibited unless it can be shown that it is a Bona Fide Occupational Qualification (BFOQ) exception.

> The Equal Employment Opportunity Commission, the agency charged with the enforcement of Title VII has stated that the BFOQ exception as to sex should be interpreted narrowly. The courts have agreed with this interpretation and have placed the burden of proving the applicability of the exception on the employer who is asserting it. The BFOQ exception must rest on something more than assumptions about the comparative employment characteristics of women in general, stereotyped characterizations of the sexes, or the preferences of co-workers, the employer or clients and customers.[17]

This narrow interpretation would mean that the Army, with regard to the physical demands standards, must prove the lack of physical strength disqualifies a person from doing a specific job.

To establish a case under Title VII one must show that a policy exists. Then it is necessary to show that the policy would exclude a substantial number of women. "Such a statistical showing is usually quite impressive and is fairly easy to generate from such common sources as the Statistical Abstract of the

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[15]Central All-Volunteer Force Task Force Office. Utilization of military women (A report of increased utilization of military women FY 1973-1977). Washington, DC: Assistant Secretary of Defense (Manpower and Reserve Affairs), December 1972, pp G-17 - G-18.

[16]P. E. Callis. Minimum height and weight requirements as a form of sex discrimination. Labor Law Journal, 1974, 25, 736-745.

[17]*Ibid*, p 73.

United States."[18] Having done this, a *prima facie* case is established which does not require proof that the defendant intended to discriminate and, in fact, the plaintiff is advised against bringing intent into the proceedings.

The employer's course of action is fairly limited:

> The only defense available to the employer once plaintiff's prima facie case is proven is that height and weight are somehow connected to ability to do the job. The degree of connection required to be shown by the employer varies according to the standards imposed by plaintiff's legal theory.[19]

For cases brought under Title VII, the court will probably require just as strong support as it would for a BFOQ exception that directly excluded women. The evidence given in defense is usually the testimony of a personnel officer, a supervisor, or someone else who knows the job. Such testimony can be refuted by showing the "expert" has no basis for the opinion, having carried out no tests or studies to confirm the requirement. The plaintiff can also call expert witnesses to refute the requirement.

Hilton has summarized a key EEOC ruling on strength requirements:

> [It] has held that where there is evidence: (1) that an employer's allocation of work responsibilities has a significantly adverse impact upon the employment opportunities of females because of their sex, and (2) that there is a reasonable alternative to the exising allocation of responsibilities which would reduce the disproportionate exclusion of females, then the employer has the burden of showing a substantial justification for not adopting the nondiscriminatory alternative.[20]

While Callis' discussion involved height and weight requirements, it is reasonable to assume that a similar prima facie case could be made against the proposed ARIEM physical fitness requirements. The existence of a policy is easy to prove since it would be contained in Army Regulations. The showing that application of the policy would disqualify more women than men could be made by citing studies such as the one reviewed in the section "Physical Fitness: Strength" in Chapter 2. It would then be up to the Army to prove the requirements were actually necessary. The type of job analysis advocated in Chapter 4 would help establish that necessity.

To be sure, the military has some specific requirements that make its placement problems different from the civilian sector. All positions with the same job title must be interchangeable to allow replacement in the event of

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[18] Ibid, p 741.

[19] Ibid, p 743.

[20] M. N. Hilton. The national scene. Journal of Occupational Medicine, 1974, 16, p 536.

mobilization require that placement procedures be as simple as possible. Still, it is desirable that the Army get the best use from its capable personnel while operating within these constraints. In terms of physical demands, this can be done by a combination of changing the soldier to fit the work and changing the work to fit the soldier. The former can be accomplished by providing the best possible physical fitness training for every soldier, regardless of MOS, age, or sex. There are limitations to how much physical fitness can be improved, however, so the second alternative of job modification must be considered in more detail in the next chapter.

Chapter 4

PROPOSED JOB ANALYSIS STUDY

Those MOS that have their high physical demands substantiated by job analysis should then be studied to see if it is possible to reduce these demands through job modification. This can be done by task modification, task reassignment, or job aids. A task modification means changing the way something is done so that it is not as physically demanding or otherwise as difficult. This might be as simple as teaching individuals the proper way to carry heavy loads. Task reassignment would involve such things as having another person help with heavy tasks, or assignment of the heavy task to an MOS that does not have critical selection problems, but does have other tasks with high physical demand requirements. Job aids consist of providing materials handling devices such as carts to carry heavy tool boxes. By applying these modifications, it should be possible to reduce the number of MOS that have the high demands and consequently ease the selection problem.

A job analysis is needed to determine which of the physically demanding MOS should remain classified that way and which should be changed to a lower classification, either because the job can be modified or because the physical demands were incorrectly judged. To develop the procedure for this type of physical demands job analysis, the authors propose to interview the incumbents in five representative MOS. These five all have above baseline physical demands requirements,[1] and have mean AFQT scores for the males that are above the 55th percentile.[2]

<u>MOS to be studied</u>. Because the MOS requiring high aptitude individuals present the most serious selection problems, the demands analysis should start with these. To develop the job analysis method, five MOS have been selected for initial study that have either medium or high physical demands,[3] and have high mean AFQT scores for the male incumbents.[4] The Army's job description for each of the MOS was then reviewed to determine any additional factors that might influence selection.[5] A final criterion for selection was the availability of soldiers in the MOS at Fort Hood, Texas, where the research project is located. The number of individuals at each pay grade who were assigned to

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[1]J. E. Wright and J. A. Vogel. <u>Physiological demands of MOS clusters: Estimates and classification of army MOS fitness demands</u> (undated report received December 1979). Natick, Massachusetts: US Army Research Institute for Environmental Medicine.

[2]Defense Department Data Center (DMDC) files dated September 1978.

[3]J. E. Wright and J. A. Vogel, <u>op cit</u>.

[4]DMDC, <u>op cit</u>.

[5]US Department of the Army. <u>Army Regulation 611-201</u> (Change 11). Washington, DC: January 1, 1979.

the MOS compared with the authorized number was obtained from Army personnel headquarters to determine if shortfalls existed.[6] The next step was to list the physical tasks identified by ARIEM as justifying a physically demanding cluster. The actual job modifications cannot be determined without observing the tasks, of course, but an examination of the tasks gives an idea of how job modifications might be accomplished. The five MOS selected were in signal (05B), engineering (52D), transportation (67V), medical (91B) and intelligence (98G) specialties. A detailed description of the physical demanding tasks for each of the selected MOS, shortfalls that currently exist in the specialty, and the kind of changes that might be made in tasks are given below.

Radio Operator (05B). This specialty is assigned to cluster DELTA, meaning it has medium strength and low stamina standards. Only 89% of the positions in 05B are filled, with the largest shortfalls in pay grades E1 to E3 where 83% of the positions are filled. Candidates must meet specific aptitude requirements and the mean AFQT of male incumbents is the 59th percentile. Additional requirements are a security clearance and satisfactory performance on an auditory perception test. The three demanding tasks identified for 05B all involve carrying and installing heavy electronic equipment. These tasks have to be done in a tactical situation, which means working in any kind of weather and possibly while wearing protective equipment. The heaviest item weighs 34 kg (75 lb.) and must be carried 8 meters (25 ft.). A task modification such as having two persons carry the heavy equipment seems the most likely solution. These tasks are carried out only when establishing or moving the unit so the small additional time lost by using the additional person should not hamper the mission.

Power Generation Equipment Repairer (52D). This specialty is assigned to cluster CHARLIE, which means it has high strength and low stamina requirements. The MOS is at 130% of authorized strength. The only shortfall is at the E5 level which has 92% of the authorized positions filled. Candidates must meet a specific aptitude requirement and the mean AFQT of male incumbents is the 56th percentile. The only other requirement is normal color vision. The extra personnel over authorized strength indicates this is a popular specialty, which is not likely to have a selection problem. Three physically demanding tasks were identified, one being to move the heavy tool box about the shop, and the other two being to lift heavy parts or equipment. The tool box weighs 23 kg (50 lb.) which should present no problems. The heavy parts or equipment were a different matter. In one case, an engine weighing 45 kg (100 lb.) must be moved to the service bench. A helper might be of use in this situation. In the other case, a 30 kg (65 lb.) starter must be installed on an engine. This task needs to be examined to see other ways it might be accomplished. The 52D MOS is one that may not be possible to modify.

Observation/Scout Helicopter Repairer (67V). This specialty is assigned to cluster CHARLIE, which means it has high strength and low stamina requirements. The MOS is at 119% of authorized strength with small shortfalls of personnel in pay grades E5 (92%) and E4 (97%). Candidates must meet a specific aptitude requirement and the mean AFQT for males is the 55th percentile. The MOS also requires normal color vision and no record of involvement with narcotics. The number of individuals over authorized strength indicates this

[6]US Army Military Personnel Center (MILPERCEN).

is a popular specialty and the moderate aptitude level indicates few selection problems. One demanding task was identified which was handling a 41 kg (90 lb.) tool box several times a day. Several changes could be made to reduce this type of requirement. First, the weight of tools in the box could be reduced by putting only the essential items in the portable box and leaving the rest in a consolidated tool box. The weight could be distributed between the two boxes which would be eaiser to carry. Finally, the box could be put on a cart which would make it easier to move on the flight line. An Air Force study of tool boxes found most respondents reported they either used a consolidated tool kit or carried only those tools needed out to the aircraft.[7]

Medical Specialist (91B). This specialty is assigned to cluster ALPHA, which means it has high strength and high stamina standards. The MOS is at 91% of its authorized level. Pay grade E4 has the largest shortfall with only 75% of its authorized personnel. Candidates must meet specific aptitude requirements and the mean male AFQT is the 58th percentile. A moderate formal training program is also required. The high physical demand standards are likely to aggravate the shortfalls in this MOS. Nine physically demanding tasks were identified. These include handling patients, moving casualties, administering cardiopulmonary resuscitation, handling supplies, preparing a field facility, and working with infantry units. The moving tasks require carrying a patient weighing up to 82 kg (180 lb.) on a litter with one person at each end and carrying a patient singly, without a litter, using some type of manual carry. Boxes up to 30 kg (66 lb.) may have to be loaded on or off a truck in establishing or moving a base. The tasks related to working with infantry require the ability to move across rough terrain. The infantry tasks puts 91B in the ALPHA cluster, compared with the other medical specialties in the MOS series 91 which do not have the requirement and are only put in the BRAVO cluster for high strength and medium stamina standards. The strength requirement of this specialty seems important, but it is also critical that sufficient personnel be available for all medical specialties. Some task reassignment seems possible. As long as there are some highly fit individuals in a medical unit to move patients across rough terrain, the rest of the mission could be accomplished without great strength. The loading and handling from high truckbeds could be facilitated by providing a ramp such as the type found on do-it-yourself moving equipment. This ramp slides into a compartment under the truckbed and can be pulled out when needed.

Electronic Warfare/Signal Intelligence (98G). This specialty is assigned to cluster DELTA, which means it has medium strength and low stamina standards. The MOS is at 72% of authorized strength with only 68% of the personnel in pay grades E1 through E4 currently assigned. Candidates must meet specific aptitude requirements and the male incumbents have an average on the AFQT of the 86th percentile. Foreign language ability and a security clearance are also required as well as a lengthy training period. The high aptitude requirements and an existing shortfall of personnel indicates that the physical demands could aggravate an already serious selection problem. Four physically demanding tasks have been identified. These include changing the

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[7] P. J. Bolalek and A. G. Grumblatt. A study to determine the adequacy of the tools and equipment used by air force women in the craft skills (SLSR 14-75A). Wright-Patterson Air Force Base, Ohio: Air Force Institute of Technology, January 1975.

tire on a 2.5 ton truck, moving 25 kg (55 lb.) boxes from the truck, frequently carrying 20 kg (44 lb.) over distances up to 50 meters, and driving a ground rod. With the exception of driving the ground rod, all of these tasks could be done by two persons if the weight is too much for one. Most of the specialized equipment used in this MOS is classified, so there is likely to be more than one person available because of security requirements. Changing the truck tire is a task that could benefit from a knowledge of how to do it with minimum strain. The movement of equipment could be facilitated by job aids such as the ramp discussed for MOS 91B. Whether a large number of persons have difficulty driving the ground rod remains to be seen. A job aid in the form of a closed, heavy pipe could be used for driving the rods.

The discussion of the five MOS and their physically demanding tasks indicates how jobs could be modified. The modifications listed were only suggestions as to how changes might be implemented, of course. Two of the MOS appear to have what might be termed unchangeable physical demands. The heavy engine components that must be handled by one person in 52D probably cannot be changed. This is also true of the extensive carrying of casualties that MOS 91B must do in a combat situation. The job analysis still can be of benefit to both by eliminating unnecessary requirements and substantiating necessary ones.

<u>The interview</u>. The job analysis interview will be based on a theoretical model of a job by Hanman. In this model:

a. A <u>task</u> is any single part of work, such as driving nails or answering the telephone.

b. A <u>position</u> is a group of tasks performed by one person. Every employed worker fills a position.

c. A <u>job</u> is a group of similar positions in one establishment. Usually several persons work on one job--sometimes only one person.

d. An <u>occupation</u> is a group of similar jobs throughout a nation or even throughout the world.[8]

The job analyst has to state four things in the job description:

1. What the worker is required to do,
2. How he does it,
3. Why he does it, [and]
4. The skills and physical abilities required to do it.[9]

This description should be in concrete, factual terms, not ratings which will obscure what is being done. Things such as the weight a person carries, how it is carried, how easily it is carried, and how essential the task is need to be answered specifically.

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[8]B. Hanman. <u>Physical capacities and job placement</u>. Stockholm: Nordisk Rotogravyr, 1951, p 13.

[9]<u>Ibid</u>, pp 18-19.

All of the physical demands and physical capacities that are critical must be considered.[10] Frequency, duration, and amount of the physical demands must be expressed clearly. The interview should take into account the different dimensions of physical strength as it relates to the task.[11] The presence of other workers in the unit or shop who could help with the work must be noted. Actual experiences with difficult tasks will be recorded, including those that were too difficult and those that may have produced injury.[12] Interviewees will be questioned about whether other persons in the same MOS have had trouble doing a task because of the physical demand. Comments about possible changes to reduce the physical demand will be solicited. From this initial, open-ended interview, a more structured form will be developed for further study. The questions to be used in the initial interview have been taken from a number of sources.[13,14,15,16] These questions are listed in Appendix A.

This project consists of the following activities:

1. A review of the literature on physical fitness and selection (completed with this report).

2. Development of an extended on-the-job, structured interview technique to: (a) assess the size and frequency of physically demanding tasks, (b) determine who carries them out, and (c) determine what changes might be made.

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[10] G. L. Germain, C. G. Browne, and R. M. Bellows. Measuring men and jobs: Criteria for physical analysis forms. Personnel and Guidance Journal, 1953, 31, 245-249.

[11] E. A. Fleishman. The structure and management of physical fitness, Englewood Cliffs, New Jersey: Prentice-Hall, 1964.

[12] D. B. Chaffin. Human strength capability and low-back pain. Journal of Occupational Medicine, 1974, 16, 248-254.

[13] M. M. Ayoub, R. F. Powers, N. J. Bethea, B. K. Lambert, H. F. Martz, and G. M. Bakken. Establishing criteria in assigning personnel to air force jobs requiring heavy work (AMRL-TR-77-94). Wright-Patterson Air Force Base, Ohio: Aerospace Medical Research Laboratory, July 1978.

[14] S. J. Cook and D. R. Wilkey. Social problems of enlisted women in United States air force craft skills (Masters Thesis). Wright-Patterson Air Force Base, Ohio: Air Force Institute of Technology, June 1977.

[15] Germain, et al., op cit.

[16] K. G. Koym. Development of physical demand profiles for airman career ladders (AFHRL-TR-75-67). Brooks Air Force Base, Texas: Air Force Human Resources Laboratory, November 1975.

3. This interview will then be given to incumbents in five selected MOS (i.e., 05B, 52D, 67V, 91B, 98G) which have both above minimum physical demands, have above average AFQT scores, and are available at Fort Hood for interviews.

4. A set of specific changes will be recommended for these five MOS.

5. A general procedure for conducting the interviews and developing the job modifications will be recommended.

After the interview techniques have been refined and the job modifications proposed, the procedures for a larger interview project covering all of the high physical demand, high aptitude MOS will be developed. The critical MOS for this project could be selected on the basis of the current ratio of authorized strength to actual strength for each MOS. Carrying out the job modification study proposed in this report and implementing its findings would have the immediate benefits of reducing on-the-job back injuries and reducing the chance of a successful discrimination suit against the Army. Whether adoption of the recommendations will have any effect on the selection problems in critical MOS would, of course, depend on whether the Army adopts the ARIEM physical demands classification system.

The final product of this study will be a report which will review the literature on strength and stamina, estimate the effects of selection caused by implementing physical fitness standards, report the findings from the soldiers interviewed, and report the recommendations for job modifications to the MOS studied. A second set of products will be guidelines for interviewing soldiers in other critical MOS, a method for interpreting these interviews, and a method for determining what changes can be made to those MOS.

Chapter 5

SUMMARY

The research literature on physical strength and stamina was reviewed to determine the probable impact of the physical demands classification for Military Occupational Specialities (MOS) proposed by the Army Research Institute for Environmental Medicine (ARIEM). The minimum standards for stamina were well within the capacity of the majority of current soldiers, but strength requirements may exclude a substantial number of persons, especially women, from a majority of Army jobs. The number of people excluded will depend very much opon the precise conditions for testing strength.

Many of the MOS with high physical demands are in technical areas which require persons with high mental aptitude. In many instances, there is already a personnel shortage for these jobs which will be aggravated by imposing physical demands standards, especially if many other high aptitude MOS are competing on the basis of the same strength criteria. This problem can be alleviated by changing the job to minimize the physical demands, using techniques such as job modification, job aids, or task reassignment. Not only will such changes increase the number of persons available, but these changes will also have the side benefit of reducing the number of job-related injuries. The changes will also provide wider and more efficient utilization of the pool of female soldiers available to the Army.

A research effort is proposed for examining five critical MOS that are both physically demanding (according to ARIEM standards) and that require high mental aptitude for success to develop and evaluate a general procedure for conducting job analyses related to physical demands and to recommend specific job changes for these MOS.

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APPENDIX A

QUESTIONS FOR INTERVIEWS

QUESTIONS FOR INTERVIEWS

MOS __________ Pay Grade _______ Time in Service ________ Age _____

Height ___ft___in (______cm) Weight ______lb (_____kg) Sex ______

Unit Designation ______________________________

Position Description:

Primary Duties:

Other Duties:

Task Information

Have you ever had physical trouble with any task? If so, explain.

Do any tasks make you feel tired or sore? If so, explain.

Do you know of anyone in your MOS who has physical trouble with any of the tasks? If so, explain.

What changes would you suggest to make your job physically easier?

What types of job aids could you use to make your job physically easier?

Additional questions[1]

Instructions:

Think about all the tasks you do in your present job. Consider each of the following physical characteristics and estimate how much of your job requires you to use each one in order to do the job right. In answering the questions, give the name of the task, how often it is done, how much time a day is spent doing it and what it is.

Hand-Arm Movement: How much of your job requires you to use closely guided movement of, or cooperation between, your arm and hand, or both arms and both hands? For example, what parts of your job involve taking apart or installing medium-sized components or units, or handling items in a way that requires carefully controlled movements of the hand and arm together?

Finger Dexterity: How much of your job requires you to use your fingers with quickness and skill? For example, what part of your job involves picking up and positioning or assembling small pieces, rapidly punching keys like a typewriter, or moving little items from one hand or place to another?

Body Strength: How much of your job requires you to use most of the muscles in your body to perform tasks over and over? For example, what part of your job involves withstanding muscular fatigue in the shoulders, back, and legs which results from actions like constantly driving screws with a manual tool?

Hand-Arm Strength: How much of your job requires you to use your hands and arms for things like pushing, pulling or moving medium to large sized objects? For example, what part of your job involves gripping tools, tightening or loosening nuts, bolts, or screws, or doing tasks that require more than just a little strength in your arms and hands?

Physical Effort: How much of your job requires you to use movements or positions that are tiring like working with your arms extended over your head? For example, what part of your job is done while working in cramped spaces, continuously guiding heavy objects into position, or scrambling up and down ladders, scaffolds, or stairs?

Eye-Hand Coordination: How much of your job requires you to use careful coordination between your eyes and hands? For example, what part of your job involves close movements like soldering small wires, measuring small amounts accurately, or guiding very small items into holes like threading a needle?

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[1]K. G. Koym. Development of physical demand profiles for four airman career ladders (AFHRL-TR-75-67). Brooks Air Force Base, Texas: Air Force Human Resources Laboratory, November 1975. (AD A020 118)

Body-Coordination: How much of your job requires you to use total body control? For example, what part of your job demands good balance and ability to move quickly and easily (not necessarily using any strength), like climbing a ladder while carrying something which prevents use of hands to control your body?

Hand-Arm Steadiness: How much of your job requires a steady fixed positioning of the hand and arm? For example, what part of your job involves holding one position without shaking or wavering, like welding, or holding a pistol on target?

Precision: How much of your job requires making close or fine adjustments? For example, what part of your job demands turning knobs or dials in very small degrees, or moving levers or controls quickly and accurately, like in tuning or lining up a pointer on a line scale?

Reaction Time: How much of your job requires you to do something quickly after you get a signal by sight or by sound? For example, what part of your job involves something like flipping a switch, pushing a lever, or turning a valve immediately after hearing a signal?

Job Standards Questions[2]

Are you strong enough to accomplish the tasks in your MOS?

If the answer is NO, explain.

Do you have enough stamina to accomplish the tasks in your MOS?

If the answer is NO, explain.

Is the physical workload in your MOS heavier than you expected?

If the answer is YES, explain.

Do you need physical help to accomplish any tasks that other persons in your job are able to accomplish alone?

If the answer is YES, explain.

Is the equipment you work with too bulky or poorly designed physically for you to handle it?

If the answer is YES, explain.

Do you use any safety equipment or special clothing?

If the answer is YES, what is the equipment and is it satisfactory?

Is your height a problem for performing any tasks?

If the answer is YES, explain.

Is your size a problem for performing any tasks?

If the answer is YES, explain.

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[2] S. J. Cook and D. R. Wilkey. Social problems of enlisted women in United States air force craft skills (Masters Thesis). Wright-Patterson Air Force Base, Ohio: Air Force Institute of Technology, June 1977. (AD A054 169)

Physically Demanding Task Description
(adapted from Table 3)[3]

USE ONE SHEET FOR EACH PHYSICALLY DEMANDING TASK

Task Description:

Temporal
Frequency __________(times)/__________(time unit)
Duration ___________(time)
Work Practices
Shift _____(Y/N) Fixed __________(period)
Rotating _______(period) _________cycle
Rest Period ________(length) _______________________(when)

Group Size __________________(number of helpers)

Forces
Lift or lower _________(Weight)
start __________(height) stop _______(height)
Push ________(amount)_________(distance) __________(time)
Pull ________(amount)_________(distance) __________(time)
Carry________(amount)_________(distance) __________(time)
Torque_______(amount)_________(rotation degrees/distance)
_______(amount)_________(crank revolution/direction)
Other _______(type) _________(amount)_________(distance) ________(time)

Load ____________(weight)_____________(distance from center of body)
_____________(height from ground)

Additional questions for each task:

Is this task difficult for you?

Why does this task have to be done this way?

Are you tired afterward?

Have you ever strained yourself?

Do you know of anyone having trouble with this task?

Could changes be made to make this task easier?

Would a job aid help you with this task?

Could you use a helper on this task?

Remarks:

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[3]M. M. Ayoub, R. F. Powers, N. J. Bethea, B. K. Lambert, H. F. Martz, and G. M. Bakken. Establishing criteria for assigning personnel to air force jobs requiring heavy work (AMRL-TR-77-94). Wright-Patterson Air Force Base, Ohio: Aerospace Medical Research Laboratory, July 1978. (AD A060 114)

APPENDIX B

CONVERSION FACTORS USED IN THIS REPORT

CONVERSION FACTORS USED IN THIS REPORT

Power[1]

1.0 kcal/min = 3087 ft-lb/min
= 69.76 watts
= .09356 hp (horse power)
1.0 hp = 10.69 kcal/min
1.0 watt = .01433 kcal/min
1.0 ft-lb/min = .0003239 kcal/min

Distance[1]

1.0 m = 3.2808 ft
= 39.39 in
1.0 cm = .3937 in
1.0 ft = .3048 m
1.0 in = 2.54 cm

Weight (mass)[1]

1.0 kg = 2.2 lb
1.0 lb = .4545 kg

Human Body Weight/mean values[2]

Male = 72.23 kg
Female = 59.97 kg

Approximation of power by oxygen uptake[3]

1.0 L/min = 5.0 kcal/min

Probability

1.0 SD = .7407 semi-interquartile range

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[1]J. Robson. Basic tables in physics. New York: McGraw-Hill, 1967.

[2]R. M. White. The anthropometry of United States army men and women: 1946-1977. Human Factors, 1979, 21, 473-482.

[3]R. J. Shephard. The energy requirements of work. Journal of Occupational Medicine, 1974, 16, 15-18.

APPENDIX C

ABBREVIATIONS

ABBREVIATIONS

AFEES: Armed Forces Entrance and Examination Station.

AFQT: Armed Forces Qualification Test.

AGCT: Army General Classification Test; used in World War II.

ARIEM: US Army Research Institute for Environmental Medicine, Natick, MS.

ARTEP: Army Training and Evaluation Program; an Army exercise.

BFOQ: Bona Fide Occupational Qualification.

cm: Centimeter.

EEOC: Equal Opportunity Commission.

ft: Feet.

in: Inches.

kcal: Kilo-calorie; the energy required to raise one kilogram of water one degree celsius.

kg: Kilogram.

L/min: Liters per minute; a power measure.

lb: Pound, United States.

m: Meter.

MAX: Maximum.

MILPERCEN: US Army Military Personnel Center.

MIN: Minimum.

ml/kg/min: Mililiters per kilogram per minute; a measure of gas volume exchange relative to body weight.

MOS: Military Occupational Specialty.

PULHES: The US Army's medical rating system; see text for explanation.

REFORGER: Return of Forces to German; an annual Army exercise.

SD: Standard deviation.

VO(2): Volume of oxygen uptake; a measure of aerobic power given in either L/min or ml/kg/min.

WAC: Women's Army Corps; no longer in existence but the term is sometimes used to refer to women soldiers.